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PENSOFT

New records of the caddisflies *Diplectrona erinya* Malicky, 2002 and *Diplectrona extrema* Banks, 1920 (Trichoptera, Hydropsychidae) from Thailand

Rungnapa Somnark[1], Narumon Sangpradub[1,2*]

1 Department of Biology, Faculty of Science, Khon Kaen University, 40002, Khon Kaen Province, Thailand • RS: s_rungnapa@kkumail.com https://orcid.org/0000-0002-7935-7680 • NS: narumon@kku.ac.th https://orcid.org/0000-0003-0228-8696

2 Center of Excellence in Biodiversity, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand

* Corresponding author

Abstract. The distributions of *Diplectrona erinya* Malicky, 2002 and *Diplectrona extrema* Banks, 1920 are somewhat limited. *Diplectrona extrema* has been known in some areas of the Indochina Peninsula archipelago and *D. erinya* only at the type locality in the north of Vietnam. We provide new records of these two species, which bring the number of Thai species of *Diplectrona* to 10. These two species were collected from a protected area in Thap Lan National Park. It is obvious that these two species occur at low densities and are probably rare in Thailand.

Keywords. Aquatic insects, distribution, Dong Phayayen–Khao Yai Forest Complex, Thap Lan National Park

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Introduction

Trichoptera is an aquatic insect order with high diversity. The investigation of caddisflies in Thailand has been undertaken by Martynov (1931). He described one new species *Stenopsyche siamensis* Martynov, 1931 and recorded two species, including *Macrostemum fastosum* (Walker, 1852) (as *Macronema fastosum* Walker, 1852) and *Ganonema ochraceellum* (McLachlan, 1866) (as *Asotocerus ochraceellus* McLachlan, 1866). Intensive studies on adult caddisflies carried out by Hans Malicky and Porntip Chantaramongkol for over 30 years (Thapanya et al. 2004; Chantaramongkol et al. 2010) have increased the number of Thai caddisfly species, currently known to be 1,020 species within 31 families and 106 genera (Chantaramongkol et al. 2010; Malicky 2011, 2012; Laudee and Malicky 2014; Malicky et al. 2019).

Diplectrona Westwood, 1840 is the largest caddisfly genus in the subfamily Diplectroninae, family Hydropsychidae. It is composed of 149 known species in all biogeographic regions except Antarctica (Sun 2017; Malicky 2020; Malicky and Mey 2020; Oláh et al. 2020; Morse 2021; Nozaki 2021), and at least 84 species are present in Oriental regions (Sun 2017). In Malicky's (2002) study, three new species and five newly recorded species were reported from Thailand, namely: *D. eurydike* Malicky & Chantaramongkol, 2002, *D. harpyia* Malicky & Chantaramongkol, 2002, *D. hermione* Malicky & Chantaramongkol, 2002, *D. gombak* Oláh, 1993, *D. burha* Schmid, 1961, *D. dulitensis* Kimmins, 1955, *D. joannisi* Navás, 1932, and *D. aurovittata* Ulmer, 1906. Since then, no more new species or new records of *Diplectrona* have been reported for Thailand.

In the present study, we provide the first records of *D. erinya* Malicky, 2002 and *D. extrema* Banks, 1920 from Thailand. *Diplectrona erinya* has been known only from the type locality at Tum Dao in the north of Vietnam (Malicky 2002), whereas *D. extrema* is distributed in Borneo, Sumatra, and Java (Malicky 2002; Malicky et al. 2014).

Methods

Our study was conducted during May and June 2017 at Thap Lan National Park, Nakhon Ratchasima Province, which is a part of Dong Phayayen–Khao Yai Forest Complex, a Natural World Heritage site in the northeastern Thailand. The new records were collected from Man Fah and Wang Sa Thien Waterfalls. The stream at the Man Fah Waterfall was 2–4 m wide, with high-velocity water, and the stream-bed substrates of mainly consisted of bedrock (~70%), boulders (~28%), and a mix of cobbles, pebbles, gravels, and sand (~2%). The stream at Wang Sa Thien Waterfall was 3–5 m wide, with moderate water velocity, and the main substrates of the stream bed consisted of boulders (~80%) and bedrock (~15%), with the remaining substrates being a mixture of cobbles, pebbles, gravels, and sand (~5%). Sampling was permitted by the Department of National Parks, Wildlife and Plant Conservation (permit no. 0907.4/9470). The adult caddisfly specimens were collected with black-light traps (10 W, 12 V) that were set up overnight adjacent to the stream bank. Sites were selected that are characterized by water flow throughout the year. Specimens were preserved in absolute ethanol and transported to the Department of Biology, Khon Kaen University for sorting and identification. Characters of male genitalia were used for identification; the genitalia of males were dissected and cleared in 10% KOH solution for 1–2 h, placed in a glycerine solution and observed under a Nikon SMZ445 stereomicroscope. Identification to the species level followed Malicky (2002, 2010) and Ito and Nozaki (2018). Drawings were made using an Olympus CH30 compound microscope. The pencil drawings were scanned and digitally inked using an iPad via the Procreate application. The description of the wing, genitalia, and general character terminology follows Sun (2017); Wells and Neboiss (2018) and Ito and Nozaki (2018). The materials examined are deposited in the collection of the Freshwater Biology laboratory, Department of Biology, Faculty of Science, Khon Kaen University (KKU).

The geographical distribution map of *D. erinya* and *D. extrema* was created using SimpleMappr (Shorthouse 2010). Previous records of the species were taken from literature reviews, and for those without geographical coordinates, Google Earth was used to locate approximate collection sites.

Results

Diplectrona erinya Malicky, 2002

Figure 1A–G

Type locality. Vietnam, Tam Dao.

New record. THAILAND – Nakhon Ratchasima Province • Thap Lan National Park, Man Fah Waterfall; 14°20′31.71″N, 101°53′43.27″E; 340 m a.s.l.; 12.VI.2017; K. Piraonapicha leg.; 4 ♂, KKU.

Identification. *Diplectrona erinya* has a brown body, forewings 6.3–6.7 mm long (n = 4), apical forks I–V present, discoidal cell long, medial cell long in forewings; hind wings with apical forks I, II, III and V present, discoidal cell long (Fig. 1A). Pair of lateral filaments of abdominal segment V short, about ⅔ as long as the length of segment V (Fig. 1B), internal glands of segment V absent, internal glands of segment VI medium-sized slightly less than half width of segment VI and internal glands of segment VII relatively large about more than ½ width of segment VII in lateral view (Fig. 1B). Male genitalia: segment IX short, anterior margin convex forwards in lateral view, posterior margin with V-shaped incision above insertion of inferior appendage (Fig. 1C). Segment X in lateral view with upper margin round and dorsal subapex deeply concave, ventrolateral margin not sinuous; in dorsal view divided into paired upper and lower lobes; upper lobes subtriangular with round apex; lower lobes subtriangular with subapical protuberance on mesal edge (Fig. 1D). Inferior appendages with long basal and short apical segments, basal segment cylindrical and slightly swollen, apical segment short about ¼ as long as basal one, wide about ½ width of basal segment, slender and slightly curved mesad and with apex round in ventral view (Fig. 1E). Phallic apparatus thick basally and with apical ⅓ almost straight in lateral view (Fig. 1F), internal sclerites large and unusually shaped (Fig. 1G).

Remarks. Our specimens bear characteristic habitus, size, and other external features that are identical to *D. erinya* known from Vietnam. In the original description of *D. erinya* from Vietnam, Malicky (2002) described and illustrated the internal glands of segment VIII as medium-sized. In this study, we found a pair of internal glands in segments VI and VII of our Thai specimen.

Diplectrona erinya strongly resembles *D. uken* Ito & Nozaki, 2018 from Amami-o-shima, Japan in the shape of genitalia. According to Ito and Nozaki (2018), male genitalia of *D. uken* are distinguished from *D. erinya* by the division of segment X into a pair of large lobes. These lobes are subtriangular, with its inner margin having a stout protuberance subapically in dorsal view, and the phallic apparatus has complicated inner sclerites in *D. uken*. However, the lobes of segment X are almost rectangular in dorsal view and no such sclerites occur in the phallic apparatus in *D. erinya*. Moreover, our Thai specimens are clearly differentiated from *D. uken* by having the forewing with the discoidal cell slightly shorter than in *D. erinya*.

Distribution (Fig. 3). Vietnam: Tam Dao (Malicky 2002) and Thailand: Thap Lan National Park (first record herein).

Diplectrona extrema Banks, 1920

Figure 2A–G

Type locality. Borneo, Telang; Sumatra, Aek Tarum; Java.

New record. THAILAND – Nakhon Ratchasima Province • Thap Lan National Park, Wang Sa Thien Wa-

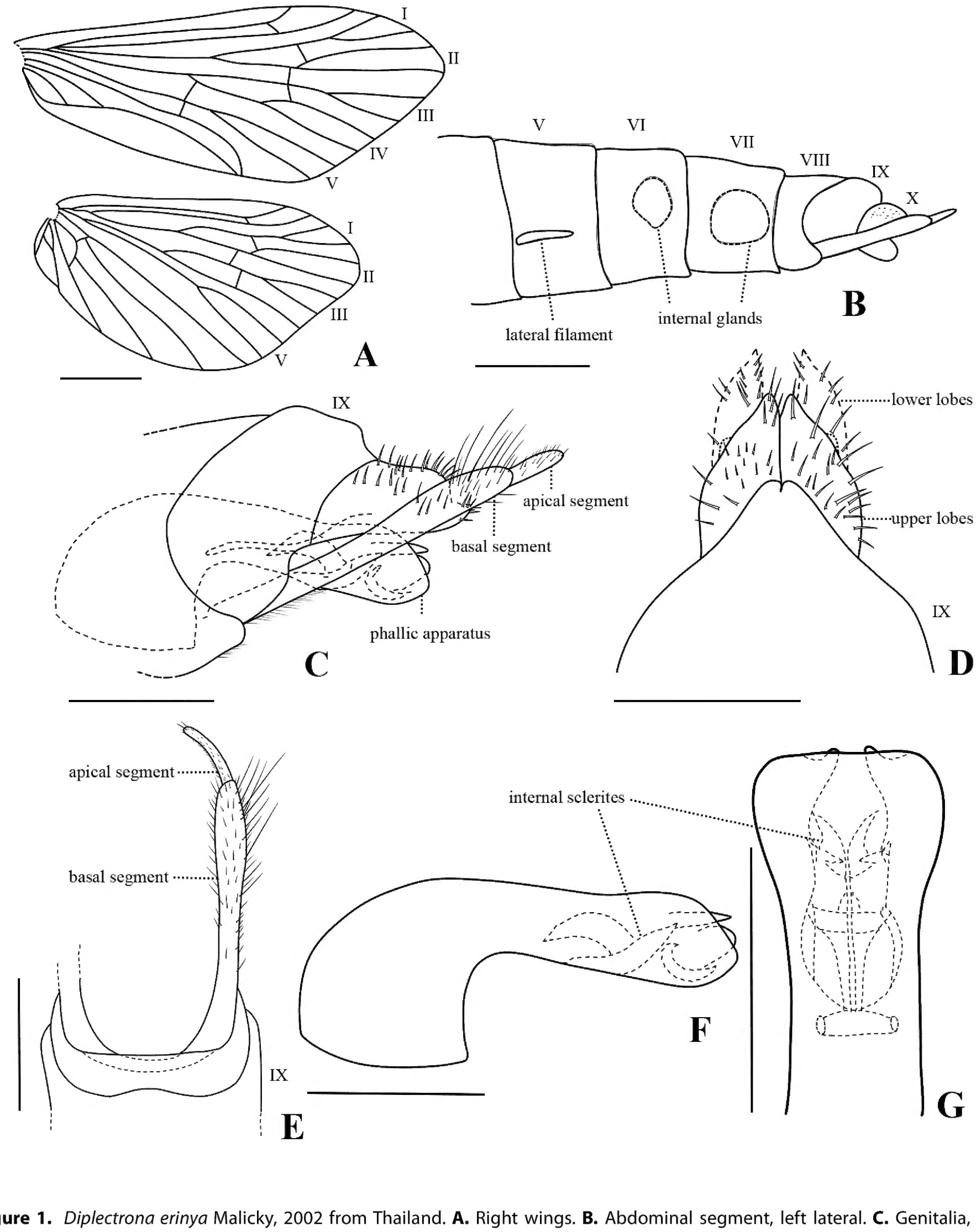

Figure 1. *Diplectrona erinya* Malicky, 2002 from Thailand. **A.** Right wings. **B.** Abdominal segment, left lateral. **C.** Genitalia, left lateral. **D.** Genitalia, dorsal. **E.** Right inferior appendage, ventral. **F.** Phallic apparatus, left lateral. **G.** Phallic apparatus, ventral. Scale bars: A = 1 mm; B = 0.5 mm; C–G = 0.25 mm.

terfall; 14°16′10.69″N, 102°23′11.63″E; 264 m a.s.l.; 11.V. 2017; K. Piraonapicha leg.; 4 ♂, KKU.

Identification. *Diplectrona extrema* has a yellowish-brown body, forewings 6.0–6.7 mm long (n = 4), apical forks I–V present, discoidal cell long, medial cell long in forewings; hind wings with apical forks I, II, III and V present, discoidal cell long (Fig. 2A). Pair of lateral filaments of abdominal segment V extend to the VII abdominal segment; internal glands of abdominal segment V medium-sized, about ½ width of its segment; internal glands of abdominal segment VIII absent (Fig. 2B). Male genitalia: segment IX annular, anterior margin convex forwardly, posterior margin produced posterodosad, dorsal margin about twice as long as ventral bridge in lateral view (Fig. 2C). Segment X well developed, subtriangular, slightly swollen with apical protuberance in lateral view (Fig. 2C), divided into two large lobes in dorsal view, each subtriangular with rounded

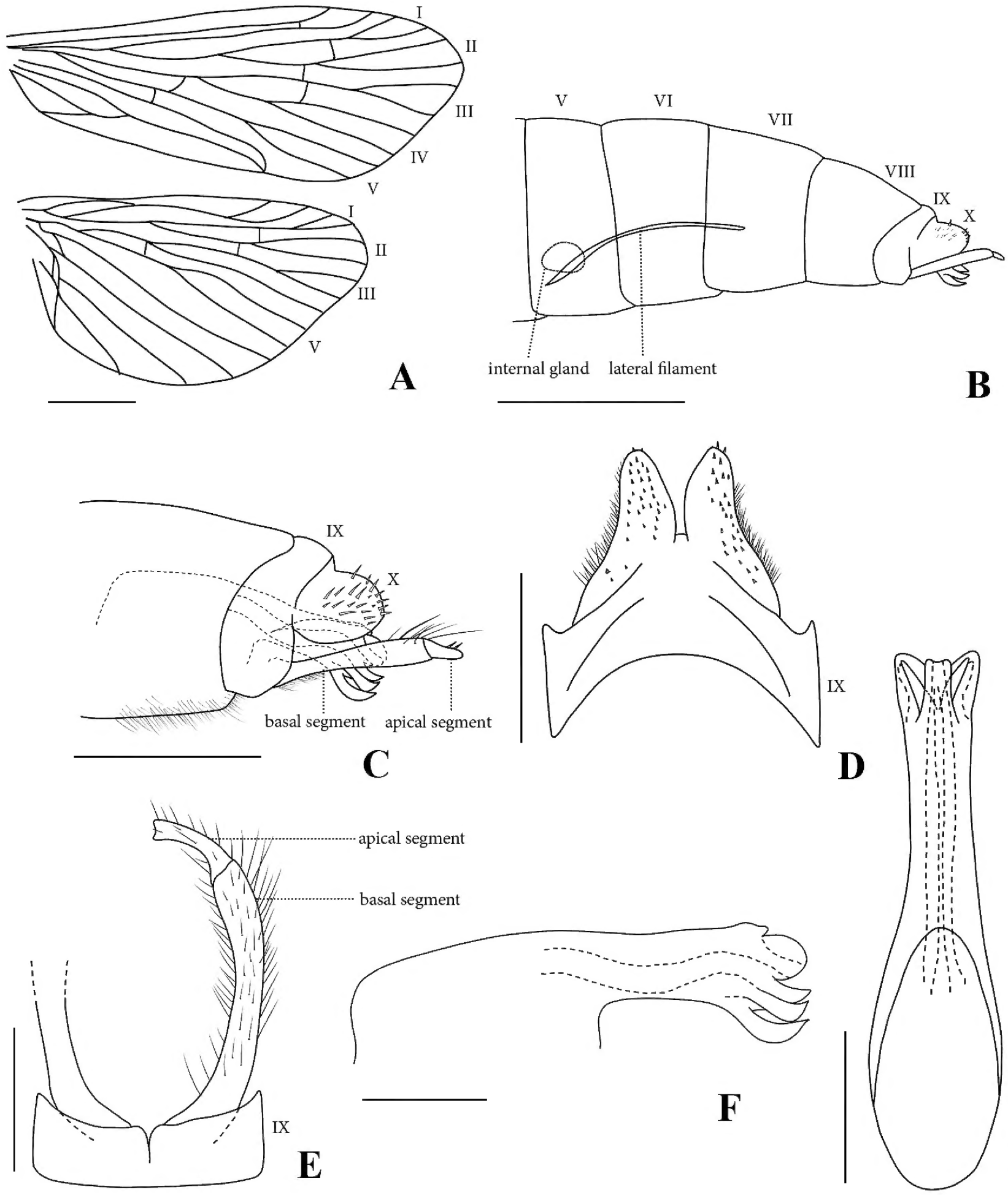

Figure 2. *Diplectrona extrema* Banks, 1920 from Thailand. **A.** Right wings. **B.** Abdominal segment, left lateral. **C.** Genitalia, left lateral. **D.** Genitalia, dorsal. **E.** Right inferior appendage, ventral. **F.** Phallic apparatus, left lateral. **G.** Phallic apparatus, ventral. Scale bars: A, B = 1 mm; C–G = 0.25 mm.

apex (Fig. 2D). Inferior appendages with long basal and short apical segments, basal segment cylindrical and slightly swollen at apical ⅓, apex truncate, apical segment short about ⅓ as long as basal one, slender and slightly curved mesad in ventral view (Fig. 2E). Phallic apparatus thick basally and with apical ½ almost straight, phallus apex divided into eight lobes: single upper lobe small and much shorter than other lobes; subdorsal pair of lobes large with rounded tips; middle pair of lobes, subventral pair of lobes, and single ventral lobe equal in length, leaf-like, upturned and acute apically in lateral view (Fig. 2F), phallic apparatus with apical lobes separated, ventral lobe in middle wide, tongue-like in ventral view (Fig. 2G).

Remarks. The new record from Thailand is clearly the same species as *D. extrema*, which was redescribed and illustrated by Malicky (2002). This species is easily distinguished from the other *Diplectrona* species with its unique character of the phallic apparatus.

Distribution (Fig. 3). Borneo: Telang, Sumatra: Aek Tarum (Malicky 2002), Java, Sumatra (Malicky et al. 2014) and Thailand: Thap Lan National Park (first record herein).

Discussion

Diplectrona erinya had been recorded at one locality in the north of Vietnam (Malicky 2002) and *D. extrema* in

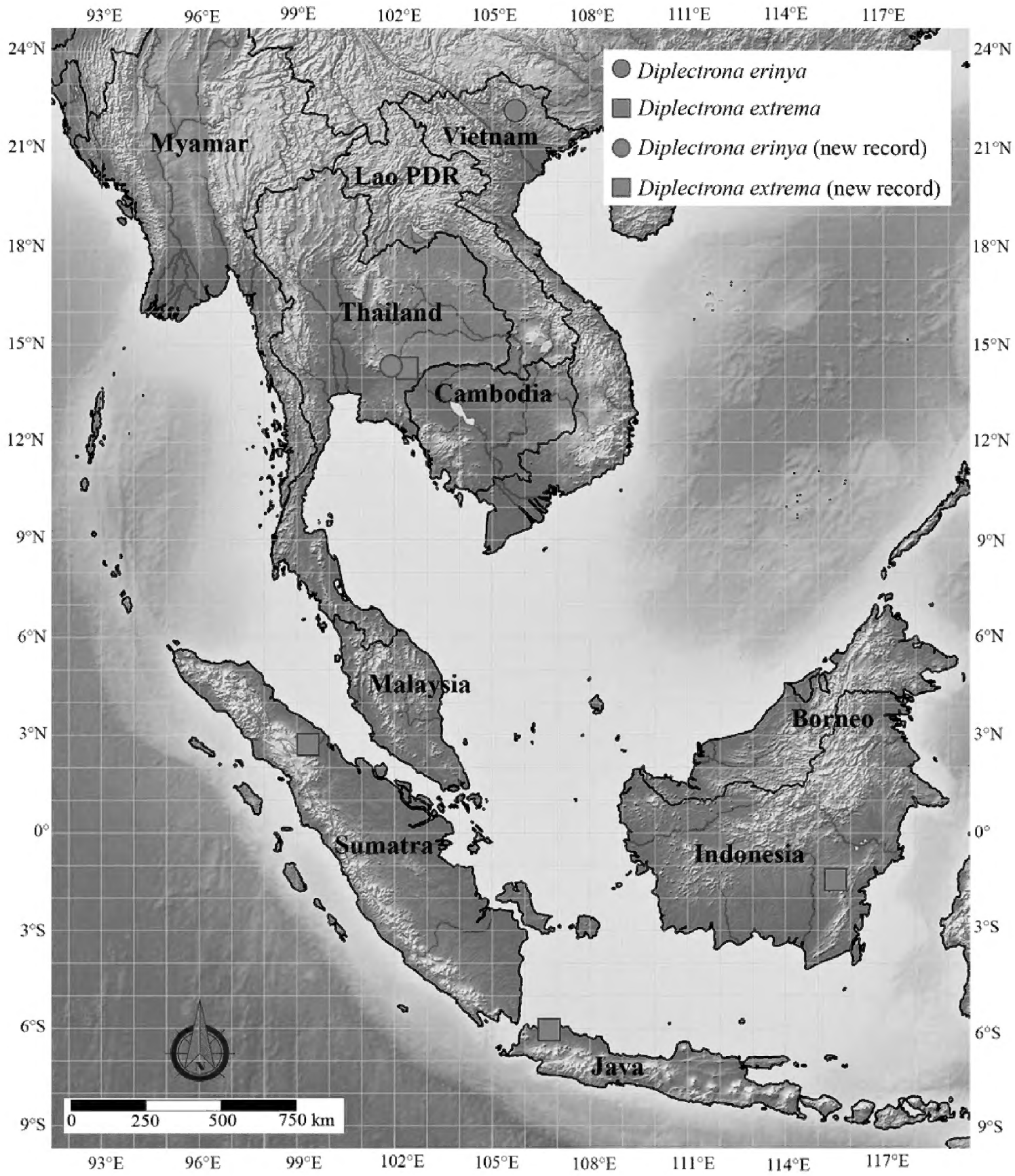

Figure 3. Geographical distribution of *Diplectrona erinya* Malicky, 2002 and *D. extrema* Banks, 1920. The yellow circle and yellow squares indicate other records; the blue circle and blue square are our new records from Thailand.

the Indochina Peninsula archipelago on Borneo, Sumatra, and Java near the equator (Malicky 2002; Malicky et al. 2014). Although there have been several reports of caddisflies from many areas of Thailand, there are no records of *D. erinya* and *D. extrema* (Chantaramongkol and Malicky 1989; Malicky and Chantaramongkol 1989, 1992, 1993, 2000, 2007). In the present study, we extend the geographic distribution of these two species to Thap Lan National Park, Dong Phayayen-Khao Yai Forest Complex, northeastern Thailand. With the addition of the new data reported here, the number of Thai *Diplectrona* species is increased to 10. The distributions of each *Diplectrona* species in Thailand and Southeast Asia are presented in Tables 1 and 2.

From observations of our specimens, some characters vary slightly from what has been described previously. This may be geographically based intraspecific variation. Segment X of *D. erinya* are medially divided into two lobes on each side; the apex of the lower lobes is pointed in our Thai specimens, while the specimen from Vietnam is stout in dorsal view. Thai specimens *D. extrema* more closely resemble the cotype from Borneo than specimens of this species from Sumatra. In dorsal view, segment X is medially divided into two large lobes, each subtriangular with a rounded apex; the lobes of specimens from Thailand and Borneo are narrower than those of the specimens from Sumatra. Moreover, the width of a tongue-like structure, part of the phallic apparatus in ventral view, is about one-third of the phallus apex in specimens from Thailand and Borneo, whereas in specimens from Sumatra it almost covers the apex of the phallus.

Among Thai *Diplectrona* species, four (*D. burha*, *D. dulitensis*, *D. eurydike*, and *D. gombak*) occur at relatively high densities (up to 14–80 specimens/locality site), whereas six species (*D. aurovittata*, *D. erinya*, *D. extrema*, *D. harpyia*, *D. hermione*, and *D. joannisi*) occur at low densities (1–4 specimens/locality site) (Malicky 2002). Our study suggests that two newly reported species occur at low densities, which highlights the con-

Table 1. Distributions of 10 species of *Diplectrona* in Thailand.

Taxa	Distribution	References
Diplectrona aurovittata Ulmer, 1906	No details of locations in Thailand	Malicky 2002
	Doi Suthep-Pui, Doi Inthanon National Parks, Chiang Mai Province	Thapanya et al. 2004; Bunlue et al. 2012
	Doi Luang, Prayao Province	Thamsenanupap et al. 2021
Diplectrona burha Schmid, 1961	Northern and central Thailand, Ban Hui Hia, Mae Hong Son Province	Malicky 2002
	Doi Suthep-Pui National Park, Chiang Mai Province	Tapanya et al. 2004
Diplectrona dulitensis Kimmins, 1955	South and central Thailand	Malicky 2002
	Ko Hong Hill nature preserve, Songkla Province	Prommi and Permkam 2010
	Ban Lam Phun, Surat Thani Province	Laudee and Prommi 2011
	Phuket Island	Malicky et al. 2019
	Hala-Bala Wildlife Sanctuary, Narathiwat Province	Rajsuwan et al. 2021
Diplectrona eurydike Malicky & Chantaramongkol, 2002	North and central Thailand, Huai Nam Ru, Chiang Mai Province	Malicky 2002
	Doi Suthep-Pui, Doi Inthanon National Parks, Chiang Mai Province	Thapanya et al. 2004, Bunlue et al. 2012
Diplectrona gombak Oláh, 1993	South and central Thailand, Phu Luang, Loei Province	Malicky 2002
	Ban Lam Phun, Surat Thani Province	Laudee and Prommi 2011
	Phuket Island	Malicky et al. 2019
	Hala-Bala Wildlife Sanctuary, Narathiwat Province	Rajsuwan et al. 2021
	Pacho Waterfall, Budo-Su Ngi Padi National Park, Narathiwat Province	Teh et al. 2021
Diplectrona harpyia Malicky & Chantaramongkol, 2002	Doi Inthanon, Ban Khun Klang, Doi Suthep-Pui National Parks, Chiang Mai Province	Malicky 2002, Thapanya et al. 2004; Bunlue et al. 2012
Diplectrona hermione Malicky & Chantaramongkol, 2002	Doi Inthanon, Huai Sai Luang, Chiang Mai Province	Malicky 2002
	Doi Suthep-Pui National Parks, Chiang Mai Province	Bunlue et al. 2012
	Doi Suthep-Pui, Doi Inthanon National Parks, Chiang Mai Province	Thapanya et al. 2004
	Pacho Waterfall, Budo-Su Ngi Padi National Park, Narathiwat Province	Teh et al. 2021
Diplectrona joannisi Navás, 1932	North Thailand, Doi Suthep-Pi National Park, Chiang Mai Province	Malicky 2002, Bunlue et al. 2012
	Doi Suthep-Pui, Doi Inthanon National Parks, Chiang Mai Province	Thapanya et al. 2004
Diplectrona erinya Malicky, 2002	Man Fah Waterfall, Thap Lan National Park, Nakhon Ratchasima Province	Present study
Diplectrona extrema Banks, 1920	Wang Sa Thien Waterfall, Thap Lan National Park, Nakhon Ratchasima Province	Present study

Table 2. Distribution of ten *Diplectrona* species from Thailand in Southeast Asia. Abbreviations: Ba = Bali, Ja = Java, Lo = Lombok, Su = Sumatra, Bo = Borneo, Lan = Lankawee, Ma = Malaysia, Lao = Lao PDR, My = Mynmar, Vi = Vietnam.

Taxa	Ba	Ja	Lo	Su	Bo	Lan	Ma	Lao	My	Vi	References
Diplectrona aurovittata Ulmer, 1906	+	+	+	+			+	+	+	+	Malicky 2002; Amitage et al. 2005; Malicky et al. 2014; Malicky et al. 2016; Mey and Malicky 2021
Diplectrona burha Schmid, 1961						+			+	+	Malicky 2002; Amitage et al. 2005; Melnitsky et al. 2019; Mey and Malicky 2021
Diplectrona dulitensis Kimmins, 1955				+	+	+	+		+		Malicky 2002; Oláh and Johanson 2010; Oláh and Malicky 2011; Wityi et al. 2015; Melnitsky et al. 2019
Diplectrona erinya Malicky, 2002										+	Malicky 2002; Amitage et al. 2005
Diplectrona eurydike Malicky & Chantaramongkol, 2002										+	Oláh 2013
Diplectrona extrema Banks, 1920	+			+	+						Malicky 2002; Malicky et al. 2014
Diplectrona gombak Oláh, 1993						+	+				Malicky 2002; Melnitsky et al. 2019
Diplectrona harpyia Malicky & Chantaramongkol, 2002									+		Mey and Malicky 2021
Diplectrona hermione Malicky & Chantaramongkol, 2002				+		+	+		+		Malicky 2002; Oláh and Malicky 2011; Malicky et al. 2014; Mey and Malicky 2021
Diplectrona joannisi Navás, 1932							+			+	Malicky 2002; Amitage et al. 2005

tinuing need for efforts to conserve the park and to conduct more studies on the caddisfly fauna.

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Author Contributions

Conceptualization: NS, RS. Investigation: RS. Methodology: NS, RS. Resources: NS. Visualization: RS, NS. Writing – original draft: RS. Writing – review and editing: NS, RS.

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